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SUITABILITY OF POTATO VARIETIES GROWN IN NORTH-EASTERN INDIAN PLAINS FOR PROCESSING

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ABSTRACT: Tuber samples of table and processing potato varieties grown in five districts *viz.*, Hooghly, Bardhaman, Medinipore West, Bankura and Birbhum of South Bengal and two districts *viz.*, Jalpaiguri and Cooch Behar of North Bengal were collected at the time of harvest in March 2006 and 2007 and processed into fresh fried chips, French fries, flour, flakes and dehydrated chips. Simultaneously, tubers were also analyzed for important processing attributes, such as dry matter, sugars, free amino acids and total phenols. The commonly cultivated potato variety, Kufri Jyoti, showed low tuber dry matter content (13.3-19.6%), high levels of reducing sugars (75.7-240.7 mg/100 g fresh wt) and produced unacceptable chips of dark colour (score 4.5-7.0). Conversely, processing varieties, Kufri Chipsona-1, Kufri Chipsona-3, Atlantic and Lady Rosetta, contained higher dry matter content (19.3-23.3%), lower contents of reducing sugars (21.0-57.7 mg/100 g fresh wt) and produced fresh fried chips of acceptable colour (score 1.75 to 2.75). In general, processing varieties contained lower levels of free amino acids and total phenols which are desirable from processing point of view. Based on tuber shape, yield and sensory characteristics of fries, such as colour, texture and taste, three varieties *viz.*, Kufri Chipsona-1, Kufri Chipsona-3 and Kufri Surya were found to be most suitable for French fries. The recovery of flakes was maximum in Lady Rosetta (21.7%), followed by Kufri Chipsona-3 (20.8%), Kufri Chipsona-1 (19.2%) and Atlantic (19%), while the recovery from other table varieties varied between 10.1 to 16.6%. Dehydrated chips and flour also followed a similar trend as that of flakes.

INTRODUCTION

Potato production in West Bengal has witnessed a five-fold increase in the last 30 years. The area, production and productivity have increased at the rate of 3.69, 5.22 and 1.41%, respectively; contributes 24% of potato area and 30% of production of the country and is the second largest producer of potatoes. Potato productivity (23.8 t/ha) in the state is also high being second only to Gujarat (24.0 t/ha). Hooghly, Medinipore West, Bardhaman, Birbhum and Bankura are the major potato producing districts in South Bengal, while Jalpaiguri and Cooch Behar are the most important districts in North Bengal. Kufri Jyoti is the main potato variety in 2003-04 as compared to 1974-75 (13). This variety is grown in about 80-85% of the area followed by Kufri Chandramukhi, Kufri Pukhraj, Kufri Chipsona-1 and an exotic variety Atlantic. Some varieties like Kufri Jawahar, Kufri Ashoka, Lady Rosetta and Desiree are also grown in South Bengal on a small scale, while Gol or Kaccha Bhutan is quite popular and grown in Jalpaiguri and Cooch Behar districts of North Bengal. The entire produce is consumed mainly as table potatoes. Varieties like Kufri Chipsona-1 and Atlantic introduced in last 3-4 years are grown mainly as processing varieties to supply potatoes to organized and unorganised potato processing industries in the state.

With the establishment of potato processing plant by PepsiCo India Holdings Pvt. Ltd., manufacturing Lays brand of potato chips and several other organized processing

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units like GP Foods (Pogo chips), Potato King (King brand potato flakes), Faber Leather (potato flakes) in Kolkata and many unorganised industries in and around big towns in West Bengal, there is an increased demand for suitable raw material. The demand is likely to increase further with the anticipated opening of several frozen French fries producing factories in near future. The raw material requirement of processing potatoes for organized sector in India was 5 lakh MT in 2005-06. This is expected to increase several folds by 2010-11 (15). It is, therefore, imperative to study the suitability of potato varieties, grown in seven important potato growing districts of West Bengal, for processing into different processed products besides determining important processing parameters such as dry matter, sugars, free amino acids and total phenolics. This will help industries in procuring suitable raw material from nearby area at a competitive price. Cultivation of suitable processing varieties would not only solve the problem of occasional gluts after the harvest of potato crop, but would also save the wastage of precious food and will bring remunerative returns to the farmers as the processing potatoes fetch premium price.

MATERIALS AND METHODS

Sixteen tuber samples of six potato varieties grown in four districts *viz*., Hooghly, Bardhaman, Medinipore West and Bankura of South Bengal and two districts *viz*., Jalpaiguri and Cooch Behar of North Bengal were collected at the time of harvest in 2006, while during 2007, a total of 29 samples comprising 11 varieties were collected. The samples collected during 2007 included all the varieties of 2006 and some additional varieties from Birbhum district of South Bengal. During both the years, samples were collected between 6th to 13th March and evaluated for different processed products and chemical constituents between 15th to 20th March. Processed products like French fries, flour, flakes and dehydrated chips were prepared by standard procedures (11). For the preparation of fresh fried chips, eight tubers were hand peeled and bisected perpendicularly from stem to bud end. One half of the tuber was used to cut slices of 1.8 mm thickness (using an electricity operated rotary slicer) and the other half was used for chemical analysis. About 30 slices were rinsed to remove free starch, air dried and immediately fried in one litre of groundnut oil at 180°C until bubbling ceased. The fried chips were subjectively scored for colour and assigned a value according to the 1-10 scale (Lower number-better colour) of the colour chart (4). Chips up to a score of 3 were acceptable. For determining dry matter content, tubers were cut into small pieces and oven dried at 70°C to a constant weight. Tubers were analysed for reducing sugars (14), sucrose (20), total phenols (19) and free amino acids (12). The observations were recorded in three replicates for each estimation, and the data were statistically analysed (5).

RESULTS AND DISCUSSION

Kufri Chipsona-1 and Atlantic produced chips of excellent colour quality with a colour score between 1.75 to 2.75 (acceptable score up to 3) in both the years, while Lady Rosetta collected during 2007 also produced chips of very good quality (chip colour score 1.75). Kufri Chipsona-3 and Kufri Surya produced chips which were on the border line of acceptance (chip colour score 3.5). All the other varieties including Kufri Jyoti, Kufri Chandramukhi, Kufri Jawahar, Kufri Pukhraj, Kufri Ashoka, Desiree and Kaccha Bhutan produced chips of unacceptable colour with colour score ratings between 4 to 8 **(Tables 1, 2 and Fig. 1)**.

Fig. 1. Chip colour of potato varieties grown in West Bengal

Table 1. Quality and yield of chips and French fries prepared from potato varieties collected from West Bengal in March 2006.

District	Variety	Chip colour[1]	Chip yield (%)	French fries colour[1]	Fries yield (%)
Hooghly	Kufri Jyoti	5.5	24.8	3.0	36.2
Hooghly	Kufri Jyoti	5.5	25.6	4.5	31.5
Hooghly	Kufri Jyoti	6.75	20.9	2.5	37.4
Hooghly	Kufri Chandramukhi	5.5	25.6	4.0	37.7
Medinipore West	Kufri Jyoti	4.5	22.2	3.0	32.5
Medinipore West	Kufri Jyoti	5.5	23.0	3.5	36.9
Bardhaman	Kufri Jawahar	6.5	20.1	2.0	36.5
Bardhaman	Kufri Jyoti	6.25	22.0	5.0	33.7
Bankura	Kufri Jyoti	4.0	23.6	2.0	37.5
Bankura	Kufri Chipsona-1	2.25	27.4	1.0	36.7
Bankura	Atlantic	1.75	27.5	1.0	37.4
Jalpaiguri	Kufri Jyoti	6.0	20.4	2.5	37.2
Jalpaiguri	Kufri Chipsona-1	2.5	28.0	1.5	36.7
Jalpaiguri	Kufri Jyoti	6.0	19.5	3.5	35.2
Cooch Behar	Kaccha Bhutan	6.5	25.2	4.0	26.0
Cooch Behar	Kufri Jyoti	6.0	21.7	5.0	35.8
CD (P≤0.05)	-	0.63	1.2	0.25	1.6

[1]on a 1-10 scale of increasing dark colour, chip and fry colour scores up to 3 were acceptable.

Chip yield depends on tuber solid content, processing losses, and oil absorption capacity of the chips and varieties producing higher chip yield with lower oil content are desirable. Chip yield varied between 27.4 to 28% in Kufri Chipsona-1 and Atlantic during 2006 **(Table 1)**, while it ranged from 28.1 to 32% in processing varieties *viz.*, Kufri Chipsona-1, Kufri Chipsona-3, Atlantic and Lady Rosetta in 2007 **(Table 2)**. All the non-processing varieties gave lower chip yield (19.5-27.4%).

Processing varieties *viz.*, Kufri Chipsona-1, Kufri Chipsona-3, Kufri Surya, Atlantic and Lady Rosetta produced fries of highly acceptable colour (fry colour score 1-2). Similarly, Kufri Jawahar, Desiree and some of the samples of Kufri Jyoti, also produced acceptable colour fries. The fries from varieties Kufri Chandramukhi, Kufri Ashoka, Kufri Pukhraj and Kaccha or Gol Bhutan were of unacceptable colour **(Tables 1 and 2)**. The yield of French fries from processing varieties varied between 35.5 to 37.5% in both the years, while it was 26 to 37.7% and 29.6 to

Table 2. Quality and yield of chips and French fries prepared from potato varieties collected from West Bengal in March 2007.

District	Variety	Chip colour[1]	Chip yield (%)	French fries colour[1]	Fries yield (%)
Hooghly	Kufri Jyoti	5.0	23.2	2.2	35.8
Hooghly	Kufri Jyoti	5.8	24.6	3.3	34.5
Hooghly	Kufri Jyoti	5.8	23.6	4.0	35.4
Hooghly	Kufri Chandramukhi	5.5	25.5	4.0	34.7
Hooghly	Kufri Jyoti	7.0	23.1	2.7	33.9
Hooghly	Kufri Chandramukhi	6.0	24.2	3.7	37.4
Hooghly	Kufri Jyoti	4.5	23.3	4.0	36.9
Medinipore West	Kufri Jyoti	6.3	24.9	2.0	33.5
Medinipore West	Kufri Jyoti	4.8	24.4	2.0	36.9
Bardhaman	Kufri Chandramukhi	5.3	27.4	3.5	35.8
Bardhaman	Kufri Jyoti	7.5	21.9	3.0	36.5
Bardhaman	Kufri Jyoti	6.0	24.2	4.5	33.7
Bardhaman	Kufri Pukhraj	5.8	25.8	3.5	33.5
Bankura	Kufri Chipsona-1	2.5	28.8	1.2	36.7
Bankura	Atlantic	2.3	28.9	1.3	36.4
Bankura	Kufri Chipsona-3	3.5	28.6	1.5	37.5
Bankura	Kufri Surya	3.5	26.9	1.2	36.8
Birbhum	Kufri Chipsona-1	2.8	28.1	2.0	35.5
Birbhum	Lady Rosetta	1.8	32.0	1.2	36.5
Birbhum	Kufri Pukhraj	7.8	25.2	5.2	34.2
Birbhum	Kufri Ashoka	6.3	20.3	4.5	33.8
Jalpaiguri	Kufri Jyoti	7.0	22.8	3.0	35.2
Jalpaiguri	Kufri Chipsona-1	2.0	29.9	1.3	35.7
Jalpaiguri	Kufri Jyoti	6.5	20.3	2.0	35.2
Jalpaiguri	Gol Bhutan	8.0	26.5	6.0	31.2
Cooch Behar	Kufri Jyoti	7.0	26.5	3.7	33.9
Cooch Behar	Desiree	6.3	23.6	1.6	34.1
Cooch Behar	Kufri Chipsona-1	2.3	29.7	1.2	36.9
Cooch Behar	Gol Bhutan	7.5	23.9	5.0	29.6
CD (P≤ 0.05)	-	0.6	1.12	0.4	1.31

[1]on a 1-10 scale of increasing dark colour, chip and fry colour scores up to 3 were acceptable.

37.4% in non-processing varieties during 2006 and 2007, respectively.

French fry quality is primarily measured by colour and texture. While light cream to golden brown is considered a good fry colour, a crisp outer crust and a soft mealy interior are desirable textural features (1). Potatoes with >20% dry matter are preferred for French fries as high dry matter is associated with mealiness, crispness and reduced oil uptake in fries. Besides, morphological characters such as shape and eye depth of the tubers are very important. Varieties with long oval to oblong shape of tubers are preferred for preparation of French fries so as to get long fries (>80 mm length). Based on morphological characters of tubers, yield and sensory characteristics of fries such as colour texture and taste, it was concluded that three varieties *viz.*, Kufri Chipsona-1, Kufri Chipsona-3 and Kufri Surya were most suitable for processing into French fries.

Flour yield was found to be positively correlated with tuber dry matter content. It was maximum in Kufri Chipsona-1 (18.2%) followed by Kaccha Bhutan (17.4%) and Atlantic (17.2%) during 2006 **(Table 3)**, while in other varieties it ranged between 14.2% to 17.4%. However, during 2007, the flour recovery was the highest in Lady Rosetta

Table 3. Yield of dehydrated chips, flour and flakes prepared from potato varieties collected from West Bengal in March 2006.

District	Variety	Dehydrated chips (%)	Flour (%)	Flakes (%)
Hooghly	Kufri Jyoti	15.2	15.6	15.9
Hooghly	Kufri Jyoti	13.2	16.1	15.4
Hooghly	Kufri Jyoti	11.6	16.5	14.0
Hooghly	Kufri Chandramukhi	9.7	15.1	16.3
Medinipore West	Kufri Jyoti	13.8	17.1	15.4
Medinipore West	Kufri Jyoti	16.9	16.4	16.6
Bardhaman	Kufri Jawahar	12.7	14.3	13.9
Bardhaman	Kufri Jyoti	15.2	17.4	14.5
Bankura	Kufri Jyoti	13.8	14.7	13.6
Bankura	Kufri Chipsona-1	16.3	16.8	14.3
Bankura	Atlantic	16.6	17.2	17.4
Jalpaiguri	Kufri Jyoti	11.6	14.3	13.4
Jalpaiguri	Kufri Chipsona-1	17.9	18.2	16.9
Jalpaiguri	Kufri Jyoti	14.3	14.5	13.8
Cooch Behar	Kaccha Bhutan	15.5	17.4	16.9
Cooch Behar	Kufri Jyoti	12.7	14.2	11.7
CD (P≤ 0.05)	-	0.42	0.66	0.33

Table 4. Yield of dehydrated chips, flour and flakes prepared from potato varieties collected from West Bengal in March 2007.

District	Variety	Dehydrated chips (%)	Flour (%)	Flakes (%)
Hooghly	Kufri Jyoti	10.3	12.1	12.7
Hooghly	Kufri Jyoti	11.2	11.0	12.6
Hooghly	Kufri Jyoti	12.7	13.2	12.7
Hooghly	Kufri Chandramukhi	14.9	15.9	16.5
Hooghly	Kufri Jyoti	11.6	13.3	11.7
Hooghly	Kufri Chandramukhi	13.2	14.8	15.2
Hooghly	Kufri Jyoti	14.6	13.5	14.7
Medinipore West	Kufri Jyoti	14.8	15.7	15.6
Medinipore West	Kufri Jyoti	13.7	15.0	14.8
Bardhaman	Kufri Chandramukhi	12.2	15.1	14.9
Bardhaman	Kufri Jyoti	13.8	15.6	15.1
Bardhaman	Kufri Jyoti	8.6	13.8	11.3
Bardhaman	Kufri Pukhraj	14.5	15.6	14.7
Bankura	Kufri Chipsona-1	13.8	16.4	19.2
Bankura	Atlantic	13.7	19.1	19.0
Bankura	Kufri Chipsona-3	17.2	19.9	20.8
Bankura	Kufri Surya	12.5	14.9	14.3
Birbhum	Kufri Chipsona-1	13.3	16.9	16.8
Birbhum	Lady Rosetta	17.5	19.9	21.7
Birbhum	Kufri Pukhraj	11.6	13.6	13.3
Birbhum	Kufri Ashoka	10.2	13.4	14.5
Jalpaiguri	Kufri Jyoti	15.0	13.4	14.1
Jalpaiguri	Kufri Chipsona-1	13.8	17.2	16.7
Jalpaiguri	Kufri Jyoti	11.3	13.0	10.1
Jalpaiguri	Gol Bhutan	12.6	15.2	14.9
Cooch Behar	Kufri Jyoti	14.9	15.1	13.0
Cooch Behar	Desiree	10.6	15.1	14.7
Cooch Behar	Kufri Chipsona-1	13.9	18.9	17.6
Cooch Behar	Gol Bhutan	14.8	15.6	14.4
CD (P≤ 0.05)	-	0.53	0.78	0.43

Table 5. Processing parameters of potato varieties collected from West Bengal in March 2006.

District	Variety	Tuber dry matter (%)	Reducing sugars[1]	Sucrose[1]	Free amino acids[1]	Total phenols[1]
Hooghly	Kufri Jyoti	18.2	121.0	152.6	853	83.8
Hooghly	Kufri Jyoti	18.7	171.7	119.7	952	107.2
Hooghly	Kufri Jyoti	18.3	169.3	152.2	809	83.8
Hooghly	Kufri Chandramukhi	17.4	145.7	156.0	644	52.8
Medinipore West	Kufri Jyoti	19.6	121.0	206.0	862	109.9
Medinipore West	Kufri Jyoti	19.5	240.7	201.7	833	105.6
Bardhaman	Kufri Jawahar	15.6	161.3	174.8	584	39.0
Bardhaman	Kufri Jyoti	18.1	124.3	201.7	894	93.2
Bankura	Kufri Jyoti	18.4	114.0	149.6	972	88.1
Bankura	Kufri Chipsona-1	19.3	55.0	154.2	728	58.2
Bankura	Atlantic	19.9	45.0	187.2	714	43.3
Jalpaiguri	Kufri Jyoti	17.0	96.3	107.2	1099	110.4
Jalpaiguri	Kufri Chipsona-1	20.7	57.7	169.2	785	58.9
Jalpaiguri	Kufri Jyoti	18.9	214.0	158.5	790	80.9
Cooch Behar	Kaccha Bhutan	20.1	219.3	315.8	673	68.7
Cooch Behar	Kufri Jyoti	18.6	140.7	307.7	731	74.6
CD (P≤ 0.05)	-	0.23	13.5	8.8	40.3	4.2

[1]mg/100 g fresh tuber wt.

Table 6. Processing parameters of potato varieties collected from West Bengal in March 2007.

District	Variety	Tuber dry matter(%)	Reducing sugars[1]	Sucrose[1]	Free amino acids[1]	Total phenols[1]
Hooghly	Kufri Jyoti	15.3	176.0	161.5	631	66.3
Hooghly	Kufri Jyoti	14.9	98.3	76.4	594	69.7
Hooghly	Kufri Jyoti	14.4	89.6	74.9	650	80.2
Hooghly	Kufri Chandramukhi	19.2	99.0	178.5	536	50.5
Hooghly	Kufri Jyoti	14.3	85.0	70.8	809	92.4
Hooghly	Kufri Chandramukhi	16.8	104.3	89.7	515	41.7
Hooghly	Kufri Jyoti	17.7	87.3	86.2	682	74.5
Medinipore West	Kufri Jyoti	16.9	212.7	10.3.1	535	55.1
Medinipore West	Kufri Jyoti	15.7	130.3	107.7	749	62.3
Bardhaman	Kufri Chandramukhi	17.5	80.0	114.9	484	31.4
Bardhaman	Kufri Jyoti	16.5	80.3	79.5	805	77.1
Bardhaman	Kufri Jyoti	18.1	75.7	146.7	512	66.0
Bardhaman	Kufri Pukhraj	16.4	80.0	57.4	783	58.7
Bankura	Kufri Chipsona-1	21.0	51.7	118.5	491	49.0
Bankura	Atlantic	20.1	47.0	88.7	485	28.8
Bankura	Kufri Chipsona-3	22.8	44.7	102.6	515	48.9
Bankura	Kufri Surya	17.7	60.7	109.8	626	56.6
Birbhum	Kufri Chipsona-1	19.5	30.3	140.0	539	30.1
Birbhum	Lady Rosetta	23.3	21.0	147.2	504	23.6
Birbhum	Kufri Pukhraj	14.2	124.3	95.4	519	40.9
Birbhum	Kufri Ashoka	16.0	121.7	117.9	566	66.8
Jalpaiguri	Kufri Jyoti	14.8	320.0	117.4	632	65.9
Jalpaiguri	Kufri Chipsona-1	19.6	46.3	166.7	408	43.4
Jalpaiguri	Kufri Jyoti	13.3	139.7	97.5	603	54.8
Jalpaiguri	Gol Bhutan	16.9	585.7	195.4	478	48.2
Cooch Behar	Kufri Jyoti	16.4	200.3	119.0	667	68.2
Cooch Behar	Desiree	17.7	120.7	135.4	686	67.2
Cooch Behar	Kufri Chipsona-1	20.1	41.0	173.9	453	33.9
Cooch Behar	Gol Bhutan	16.9	242.0	117.4	482	27.1
CD (P≤ 0.05)	-	0.35	8.5	12.5	32.6	3.8

[1]mg/100 g fresh tuber wt.

and Kufri Chipsona-3 (19.9%) followed by Atlantic (19.1%) and Kufri Chipsona-1 (16.4-18.9%), while the recovery from other varieties varied between 11 to 15.9% **(Table 4)**. During both the years, there were large variations in the flour recovery within the same variety collected from different districts of West Bengal. Flours prepared from Kaccha Bhutan, Kufri Pukhraj and Kufri Surya were light yellow in colour, while flours from all the other varieties were light cream in appearance.

Quality of flours prepared from all the varieties was good and acceptable. Based on flour yield, varieties like Lady Rosetta, Kufri Chipsona-3, Atlantic and Kufri Chipsona-1 were most suitable.

Yield of flakes was maximum in Atlantic (17.4%) followed by Kufri Chipsona-1 (16.9%) and Kaccha Bhutan (16.9%) during 2006 **(Table 3)**. However, during 2007, the flakes recovery was maximum in Lady Rosetta (21.7%) followed by Kufri Chipsona-3 (20.8%), Atlantic (19%) and Kufri Chipsona-1 (16.7-19.2%) **(Table 4)**. There were large variations in the recovery of flakes within the same variety collected from different districts of West Bengal. Flakes prepared from all the varieties were acceptable in colour. Based on yield of flakes, varieties Lady Rosetta, Kufri Chipsona-3, Atlantic and Kufri Chipsona-1 were found most suitable.

Dehydrated chips followed a similar pattern as that of flour and flakes. During 2006, both Kufri Chipsona-1 (16.3-17.9%) and Atlantic (16.6%) gave higher yield of dehydrated chips **(Table 3)**, while during 2007, Lady Rosetta gave maximum yield (17.5%) followed by Kufri Chipsona-3 (17.2%) **(Table 4)**. Although, the colour of dehydrated chips after frying was acceptable from most of the varieties, but the chips made from Kufri Chipsona-1, Kufri Chipsona-3, Lady Rosetta and Atlantic were very light in colour and highly acceptable.

Dry matter is one of the most important characters determining the end use of potatoes in processing industry and the production efficiency of the processing plant. High dry matter results in higher yield of processed products, mealiness, crispness and reduced oil consumption in fried products (6). A dry matter content of >20% is considered ideal for making chips, French fries and dehydrated products (3). The dry matter content of popular variety Kufri Jyoti, from different districts of West Bengal, ranged from 17% to 19.6%, while processing varieties, Kufri Chipsona-1 and Atlantic, grown under contract farming in Bankura district, had 19.3 to 20.7% dry matter during 2006 **(Table 5)**. However, during 2007, processing varieties, Lady Rosetta, Kufri Chipsona-3, Kufri Chipsona-1 and Atlantic showed a dry matter content of 23.3, 22.8, 19.5 and 20.1%, respectively, while all the other varieties, excepting Kufri Chandramukhi (19.2%), had a dry matter content of 13.3 to 18.1% **(Table 6)**.

Sugars content of potato tubers is of great importance in relation to processing, especially for fried products. The chip colour is dependent on 'Maillard reaction' between reducing sugars and free amino acids at high temperatures. Sucrose may also participate as substrate after undergoing heat induced hydrolysis during frying (8). The reducing sugars component is reported to be rate limiting in non-enzymatic browning reaction, however, including free amino acid content has been reported to augment the prediction of chip colour (2).

Fresh fried chips prepared from varieties having high reducing sugars turn dark brown and become unacceptable. Generally, good quality chips are produced if the reducing sugars content of potatoes is <0.1% on fresh

tuber wt (10). The reducing sugars content of processing varieties, Atlantic and Kufri Chipsona-1 was very low (45.0-57.7 mg/ 100g fresh wt), while all other varieties contained higher levels of reducing sugars (96.3-240.7 mg/100g fresh wt) in 2006 **(Table 5)**. Likewise, processing varieties, Lady Rosetta, Kufri Chipsona-3, Kufri Chipsona-1 and Atlantic contained very low reducing sugars (21-51.7 mg/100g fresh wt) as against higher reducing sugars in other varieties (75.7-585.7 mg/100g fresh wt) in 2007 **(Table 6)**. A positive relationship between reducing sugar content and chip colour intensity has been reported (10, 18).

Processing quality of potatoes is mainly dependent upon several factors, which include variety, the environmental conditions and agronomical practices during crop growth, and several post-harvest factors including storage. Variety and temperatures prevailing during the growth and harvest are most important for obtaining potatoes suitable for processing (7, 10). Regions of the country having mild climate with night temperatures not touching below 10°C generally produce high tuber dry matter and low reducing sugars, which are prerequisite for processing (3). Earlier, it was presumed that potatoes grown in the extreme cold conditions of northern plains were not suitable for processing due to lower accumulation of dry matter and higher reducing sugars. However, the production of processing grade potatoes from Chipsona varieties in cold northern plains proved that these varieties were temperature insensitive (9, 10). For Indian processing varieties, it is recommended that nitrogen should be applied at the rate of 270 kg/ha to achieve maximum proportion of processing-grade tubers and total yield, high dry matter/specific gravity, permissible level of low reducing sugars and superior chip colour. Phosphorus and potassium should be applied at the rate of 80 kg P_2O_5/ha and 150 kg K_2O/ha to obtain maximum yield and high yield of processing grade tubers and planting should be done at a inter and intra-row spacing of 67.5 and 20 cm for production of chipping grade tubers.

In 2006, the sucrose content in different varieties ranged from 107.2 mg/100 g fresh wt (Kufri Jyoti) to 315.8 mg/100 g fresh wt (Kaccha Bhutan). It varied between 154.2 and 187.2 mg/100 g fresh wt in Kufri Chipsona-1 and Atlantic **(Table 5)**. The sucrose accumulation in some varieties was low in 2007 because of the stage of crop maturity (7). During 2007, the sucrose content ranged from 57.4 mg/100 g fresh wt (Kufri Pukhraj) to 195.4 mg/100 g fresh wt (Gol Bhutan). The processing varieties *viz*., Lady Rosetta, Kufri Chipsona-3, Kufri Chipsona-1 and Atlantic showed average levels of sucrose **(Table 6)**.

The free amino acids content in varieties in 2006 ranged from 584 mg/100 g fresh wt in Kufri Jawahar to 1099 mg/100 g fresh wt in Kufri Jyoti. Processing varieties, Atlantic and Kufri Chipsona-1 showed lower levels of free amino acids (714-785 mg/100 g fresh wt) in comparison to Kufri Jyoti **(Table 5)**. In 2007, Kufri Chipsona-1 from Jalpaiguri contained the least free amino acids content (408 mg/100 g fresh wt), while Kufri Jyoti from Hooghly showed the highest level (809 mg/100 g fresh wt) **(Table 6)**. In general, processing varieties contained lower levels of free amino acids which may be responsible for imparting low intensity of chip colour. It is known that chip colour is dependent both on the content of reducing sugars and amino acids (16).

Phenolic compounds are associated with enzymic discolouration, an undesirable trait which occurs due to the oxidation of these compounds by polyphenoloxidase and

observed during peeling and slicing of tubers (9, 17). In samples collected in 2006, Kufri Jyoti contained higher levels of total phenols (74.6-110.4 mg/100 g fresh wt), while processing varieties, Atlantic and Kufri Chipsona-1 had lower levels (43.3-58.9 mg/100 g fresh wt) **(Table 5)**. In 2007, Lady Rosetta contained lowest total phenols (23.6 mg/100 g fresh wt), whereas, Kufri Jyoti, a popular variety of West Bengal contained very high levels (55.1-92.4 mg/100 g fresh wt) **(Table 6)**. The processing varieties, in general, contained lower levels of total phenols which is desirable from processing point of view.

Based on evaluation of potato varieties for different parameters, it was concluded that commonly cultivated variety Kufri Jyoti grown in West Bengal possessed poor quality traits, such as lower dry matter, higher reducing sugars and was not suitable for processing into fried and dehydrated products. Processing varieties, Kufri Chipsona-1, Kufri Chipsona-3, Atlantic and Lady Rosetta contained higher dry matter, lower levels of reducing sugars, free amino acids and total phenols and were most suitable for the preparation of chips and dehydrated products such as flakes, flour and dehydrated chips.

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